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UNITED STATES PATENT APPLICATION

of

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for

SYSTEM AND METHOD FOR BONDING AN ACRYLIC SURFACE TO A FRAME

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Field of the Invention

The present invention relates to a system and method for bonding an acrylic surface to a frame. More particularly, the present invention is directed to a system and method for adhesively bonding an acrylic basketball backboard to a frame structure.

Background

As the game of basketball has increased in popularity, a greater number of people have purchased basketball systems for use at their homes. Such basketball systems typically comprise at least a pole to which a backboard and a goal is secured so that the goal is suspended above a playing surface. The basketball backboard can be made of a variety of materials including various polymers and composites. Clear acrylic backboards are becoming increasingly popular because they resemble professional backboards.

There are several problems which must be overcome to successfully use an acrylic basketball backboard. First, the backboard must be adequately bonded to a support frame. Second, there must be sufficient flexibility in the bond to dissipate the impact energy from the backboard to the frame. If the bond between the backboard and frame is too rigid,

then the backboard can fracture. If the bond is too loose, then the adhesion fails.

One successful resolution of this problem has been the use of two-sided tape having a foam center. One suitable tape, known as "VHB" tape, is commercially available from 3M and Norton. The tape is typically applied to the frame structure, and then the acrylic backboard is pressed on the taped frame.

A significant problem with the use of the two-sided tape described above is the time and labor required to apply the tape to the frame. Currently, substantial manual labor is used to prepare the acrylic backboard surface and frame surface to receive the adhesive tape, to manually lay the tape, and to press the taped backboard and frame together. It would be a substantial improvement in the art to automate the labor-intensive steps in assembly of an acrylic basketball backboard.

Such an automated system and method for bonding an acrylic surface to a frame is disclosed and claimed herein.

Summary of the Invention

The present invention relates to an acrylic basketball backboard assembly and to a method of bonding an acrylic basketball backboard to a frame structure. The assembly includes a basketball backboard frame structure and an acrylic backboard which are bonded together with a suitable elastomeric adhesive. Silicone adhesive is currently pre-

ferred because of its excellent adhesion and flexibility and low cost. The elastomeric adhesive replaces conventional VHB double-sided tape. Applying adhesive to either the backboard or frame structure can be automated and performed by commercially available robotic equipment, thereby improving the efficiency and cost of the basketball backboard assembly process.

A significant problem with most elastomeric adhesives is the long cure time. This problem was solved according to the present invention by using a catalyzed adhesive. The amount of cure catalyst used can vary to provide an optimum set time. Currently, the adhesive is configured to provide a set time in the range from about 5 minutes to 1 hour, and more preferably from about 7 to 15 minutes.

Another problem with elastomeric adhesives was the need to provide controlled and reproducible adhesion and flexibility of the adhesive bond. It was observed that the bond gap directly affected adhesion and flexibility. For example, if the bond gap was too great, good flexibility was observed at the expense of adhesion, with cohesive failure occurring. If the bond gap was too little, good adhesion was obtained at the expense of flexibility. Thus, there was a need to control the bond gap. The currently preferred adhesive bond gap is in the range from about 2 to 2.5 mm.

The bond gap is preferably controlled according to the present invention by including a plurality of bond gap spacers within the adhesive bond. The bond gap spacers are

positioned between the frame bonding surface and the backboard bonding surface to provide the bond gap. A variety of different bond gap spacers can be used according to the present invention. Spherical beads, such as glass microspheres, are currently preferred.

Description of the Drawings

Figure 1 is a cross-sectional view of an acrylic backboard bonded to a frame structure.

Description of the Invention

The present invention is directed to an acrylic basketball backboard assembly and to a method of bonding an acrylic basketball backboard to a frame structure. Figure 1 shows cross-sectional view of a cut-away portion of an acrylic basketball backboard assembly 10. The backboard assembly 10 includes an acrylic backboard 12 bonded to a frame structure 14. The backboard 12 includes a backboard bonding surface 16, and the frame structure 14 includes a frame bonding surface 18. An elastomeric adhesive 20 is sandwiched between the two bonding surfaces 16 and 18. The elastomeric adhesive 20 replaces the VHB double-sided tape currently used with acrylic backboards.

After testing a large number of different elastomeric adhesives from different suppliers, silicone adhesive was preferred because it provides a bond of sufficient strength and flexibility, comparable to that obtained with conven-

tional foam filled, two-sided tape. It was also preferred because of its low cost and availability. Other adhesives, such as urethane, polyurethane, hot melt adhesives, methylmethacrylate, and cyanoacrylate adhesives did not perform as well as silicone in providing the desired balance between bond strength and flexibility and/or were more expensive. Although other elastomeric adhesives can be made suitable for use in the present invention, silicone adhesive is currently preferred and will be discussed below.

Suitable silicone adhesive has been obtained from General Electric (D1-SEA 210) and from Dow Corning (Q3-6093). The commercially available silicone adhesive includes dimethylpolysiloxane as a primary ingredient, with N-propylsilicate, aminopropyltriethoxysilane, 1,3,5-tris(trimethoxysilylpropylisocyanurate) as minor ingredients.

In a currently preferred embodiment, the silicone adhesive has a bond gap (labelled "A" in Figure 1) in the range from about 2 to 2.5 mm (0.08 to 0.1 inch). If the bond gap is too small, there is not sufficient flexibility in the bond to dissipate the impact energy from the backboard created when the basketball strikes the backboard. The bond between the backboard and frame is too rigid, and the backboard tends to fracture. If the bond gap is too great, there is good flexibility, but the bond is not strong enough. Adhesion failure occurs within the silicone adhesive itself and not at the bond interface with the backboard or frame.

To provide the currently preferred adhesive bond gap, bond gap spacers 22 are located between the frame bonding surface and the backboard bonding surface. Suitable spacers can be any rigid structure having the desired thickness which can maintain the gap between the frame and backboard bonding surfaces. Currently preferred bond gap spacers include spherical beads, and more preferably glass microspheres. Glass microspheres having a diameter in the range from about 2 to 2.5 mm (0.08 to 0.1 inch) function very well. Other bond gap spacers which have been used successfully include weed trimmer line and plastic beads.

One problem with conventional single stage silicone adhesive is its long cure time, typically about 24 hours or more. If the cure time is too great, then an undue amount of manufacturing space is required to store the backboard assemblies while they cure. This problem was solved according to the present invention by using a catalyzed silicone adhesive. Typical commercially available catalyzed silicone adhesives contain two parts: (1) the adhesive itself and (2) a separate catalyst which is mixed with the adhesive to initiate curing. The ratio of catalyst to adhesive is preferably combined to provide a set time in the range from 5 minutes to 1 hour, and more preferably a set time in the range from about 7 to 15 minutes. The set time is defined as the time at which the adhesive sets sufficiently to enable the backboard assembly to be moved and handled.

The present invention also includes a method of bonding an acrylic basketball backboard to a frame structure. The method can be automated and performed by a suitable robotic device, thereby substantially reducing the assembly time and manual labor previously required to prepare acrylic backboard assemblies.

In the method according to the present invention, the backboard and frame bonding surfaces are preferably prepared to receive the elastomeric adhesive. For the frame structure, this is typically performed by roughening the surface. For instance, the surface can be roughened by rubbing a scouring pad, of the type commonly found in kitchens, over the surface. The backboard frame structure is typically painted metal. The paint is preferably a powder coated paint composition.

For the acrylic surface, it must be chemically treated to break the surface tension of the acrylic surface. Although the treatment will vary depending on the adhesive used, it typically will include a chemical mixture of acetone and the adhesive itself. The appropriate acrylic surface preparation is usually provided by the supplier of the elastomeric adhesive.

It has been found that when the acrylic backboard bonding surface contains a printed image, the printing itself provides an adequate surface preparation for the elastomeric adhesive such that a separate backboard surface preparation step is not necessary.

In the method of bonding an acrylic basketball backboard to a frame structure, the elastomeric adhesive can be applied to either the acrylic backboard or frame structure bonding surface. For example, if the adhesive is applied to the bonding surface of the acrylic backboard, then the frame structure is placed against the backboard such that the bonding surface of the frame structure contacts the adhesive. Alternatively, if the adhesive is applied to the bonding surface of the frame structure, then the acrylic backboard is placed against the frame structure such that the bonding surface of the backboard contacts the adhesive.

In either case, a predetermined bond gap is maintained between the backboard bonding surface and the frame bonding surface. As discussed above, the bond gap is important to achieving a suitable balance between adhesion and flexibility. The method can include the step of positioning a plurality of bond gap spacers between the frame bonding surface and the backboard bonding surface to provide the desired adhesive bond gap. The bond gap spacers preferably provide a bond gap in the range from about 2 to 2.5 mm (0.08 to 0.1 inch). Suitable bond gap spacers comprise spherical beads, such as glass microspheres, or other structures which are compatible with the adhesive. Glass microspheres are currently preferred because they are easily dispensed using an automated dispensing device. Furthermore, when silicone adhesive is used, the glass microspheres bond to the adhesive.

The elastomeric adhesive is allowed to cure. A catalyzed adhesive can be used to tailor the set time for elastomeric adhesives.

As discussed above, The method includes the step of preparing the frame structure bonding surface and the acrylic backboard bonding surface to receive the elastomeric adhesive. For the frame structure, this is usually a roughening of the surface. For the acrylic backboard, this is usually a chemical treatment specifically formulated for the adhesive being used. However, the step of preparing the acrylic backboard bonding surface to receive the adhesive can include printing an image on the bonding surface with an ink which securely bonds to the bonding surface.

Although the bond width (labelled "B" in Figure 1) is not critical to the present invention, it is presently preferred to apply the elastomeric adhesive with a bond width in the range from about 1 cm to 2 cm.

To evaluate various elastomeric adhesives, a standard test was developed to measure adhesion and flexibility. A baseline was obtained based upon the currently used double-sided VHB tape available from 3M and Norton. A digital level was used to measure flexibility, and a torque wrench was used to test adhesion.

Test specimens consisted of a 3-inch by 6-inch piece of acrylic and a 6-inch long powder coated 1-inch by 1-inch tubing to simulate a backboard frame. The acrylic and tubing were prepped to receive the double-sided VHB tape.

Ten specimens were prepared using 3M brand VHB tape, and ten specimens were prepared using Norton brand VHB tape. The test pieces were centered and bonded with the tape and ran through a compaction roller, to simulate conventional acrylic backboard assembly. The test pieces were allowed to sit 24 hours. The electronic level and torque wrench were then used to obtain a degree of deflection and a torque force at failure. The type of failure was also noted: either cohesive failure (tape fails with adhesion to both substrate), acrylic failure (acrylic does not adhere), and powder coat failure (powder coat does not adhere). All VHB tapes pieces showed cohesive failure.

All twenty tests were averaged to establish a baseline for elastomeric adhesives to meet or exceed. The baseline was a 20° deflection at 125 inch-pounds torque.

Various elastomeric adhesives were tested from the following manufacturers: Ashland, Ciba-Giga, Dapp, Devcon, Dow Corning, Elsworth, General Electric, Goop, Hysol, H.B. Fuller, and Resin Tech Group. It was found that the catalyzed silicone adhesive having the desired bond gap obtained from 25° to 45° deflection at 160 inch-pounds torque.

It will be appreciated that the present invention provides an acrylic basketball backboard which utilizes an elastomeric adhesive, such as silicone adhesive, to replace the conventional double-sided tape. The elastomeric adhesive provides good adhesion and flexibility. Advantageously, the labor-intensive steps in assembly of an acrylic

basketball backboard can be automated using the present invention. Furthermore, the elastomeric adhesive cost can also be less than the cost of the double-sided tape.

The present invention may be embodied in other specific forms without departing from its essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description.

What is claimed is: